

**Mountain lion–human interactions on the Colorado Plateau: the effects of human use areas on mountain lion movements, behavior, and activity patterns**

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Mountain lions are the sole remaining large predator in the Southwest (aside from reintroduction efforts for the Mexican gray wolf in the eastern portion of the state) and, as such, play a unique role in parks' natural systems. They are the ecoregion's only remaining natural predators of adult mule deer, elk, desert bighorn sheep, and, recently, javelina. This project has begun to document movement patterns of mountain lions associated in and adjacent to areas of human use at Grand Canyon National Park.

Although seldom seen by visitors, simply the presence of large carnivores contributes to the richness of visitor experience. However, recent increase in the frequency of attacks on humans by mountain lions has led to human safety concerns in areas where people concentrate in mountain lion habitat. Changes in the distribution and abundance of prey, and in mountain lion hunting behavior, as well as movement of humans into areas traditionally occupied by mountain lions, have been advanced as factors contributing to increased human–mountain lion incidents.

The increase in the frequency of mountain lions attacking humans has heightened concerns of managers in areas where mountain lions and people coexist. Although mountain lions are present throughout Grand Canyon National Park and the Colorado Plateau, little is known of how they use the region's parks and monuments. With increased pressure from hunting, poaching, and habitat reduction, parks and monuments are believed to be not only refugia for these large carnivores, but also to serve as reservoirs for their populations as they disperse into these areas of high pressure. Knowing how and when mountain lions use these parks and park habitat, especially those areas frequented by park visitors, may provide the information needed to reduce the potential for mountain lion–human interactions.

Obtaining information on wild animal populations has been a long-standing logistical problem. However, the ability to detect and analyze animal sign in the wild through non-invasive techniques is becoming an integral part of wildlife research and management. Particularly with carnivores, which are generally secretive and costly to capture and study, DNA samples from field-collected hair, tissue, and feces can yield insights into the ecology of difficult-to-study creatures such as mountain lions. A three-year study of mountain lions within Grand Canyon National Park is proving that DNA sampling and analysis of genotypes is an effective, low-cost method for detecting and identifying individual mountain lions, kinship, and minimum population estimates. This study is beginning to provide a framework for other parks, particularly those on the Colorado Plateau (many of which have little or no budget to collect this information) with similar habitat types, to obtain information regarding their mountain lion populations in order to preserve an integral component of the ecosystem while providing for visitor safety. Information already gathered at Grand Canyon is providing insight into mountain lion populations, distribution, and kinship.

Although numerous techniques have been proposed for the enumeration of cougar populations, few have been simultaneously applied and rigorously evaluated for their efficacy and accuracy. The study being conducted at Grand Canyon is analyzing a variety of methodologies, including ground-based track counts in winter and summer, and mark-recapture methods combined with scent station visitation. The latter is a non-invasive technique that captures a DNA sample from hair, allowing for analysis of age, sex, kinship, and animal identification.

National parks, because they offer security from hunting and generally stable habitats, tend to attract ungulates and the predators that feed on them. Habituation of deer and elk to humans and their structures often results in them living among humans and attracting predators to these areas. Increasing elk numbers on the South Rim of Grand Canyon may have contributed to a shift in dispersion of mule deer and elk toward areas with higher human densities. This past year, we have frequently documented sites where mountain lions have killed deer, elk, and javelina on the North and South rims of the park, including the developed zones adjacent to campgrounds, schools, and residential dwellings. In addition, mitochondria and nucleic DNA analysis is starting to provide information on lion home ranges and kinship. In one year of field data collection, we have identified sixteen individuals and several kinships among these individuals. The next two years will focus on estimating home ranges.

Knowing the spatial and temporal patterns of mountain lion use in the park and focusing on areas of high human density are providing the basis for risk assessment. For example, it is possible mountain lions use developed areas only at night and retreat to secluded areas during the day when humans are most active. There appears to be an influence on lion behavior resulting from loose and feral pets and habituated and abnormal concentrations of large prey species in and around the developed zone. Further, manipulation of vegetation in and around areas of concern may directly (through loss of hunting habitat) or indirectly (through changes in distribution of deer and elk) reduce the likelihood of human-mountain lion interactions.

Understanding the adaptability of lions in the presence of humans—i.e., how and where lions spend their time, and to what extent, how, and where do lions interact with humans—has been identified by researchers as a high priority for research. Information being obtained from this research will have direct applicability to development of management alternatives. The comparative nature of this study will allow for refinement of alternatives that will be transferable to other areas throughout the range of the mountain lion, particularly on the Colorado Plateau.

The objectives of this study are to:

- Continue to document movement patterns of mountain lions, focusing on areas of high human density in Grand Canyon (river and rims) and throughout the Colorado Plateau at those parks that are interested in obtaining this information (interest has been expressed by Mesa Verde National Park and the Flagstaff area park units); and
- Relate temporal and spatial use patterns of mountain lions to areas of the parks emphasizing those areas that receive heavy human use.

In order to:

- Maintain a naturally functioning and viable population of lions;
- Ensure safety of park visitors and staff; and
- Address education of park visitors and staff on mountain lion biology in order to minimize the risk of being attacked.

Funding in 2000 allowed for the preliminary collection of baseline data regarding DNA, compilation of prey-base information, and establishment of track and vegetation transects, mainly in concentrated areas of the South and North rims. The continuation and expansion of this research, not only at Grand Canyon but at other

parks on the Colorado Plateau, will provide a larger sample size, thereby increasing the reliability of results. Concurrent studies would also allow for investigation of how mountain lions respond to varying human population densities and to levels of developments in different geographical locations.

We are just beginning to collect scientific information that allows us to evaluate human risk from observed lion behaviors. This research will allow the National Park Service to refine its management strategies and recommendations for dealing with human-lion encounters in a proactive manner.

Because lions are predators and are fully capable of killing a human, our inclination is to assume a hazardous or lethal possibility in any lion behaviors that we do not understand or are unable to interpret. Therefore, we should attempt to manage those conditions which are conducive to lion encounters and could escalate into human injury. Data from this research will enable the Park Service to establish scientifically based recommendations for management that will help ensure visitor safety and resource protection.

#### References

- Ackerman, B.B., F. Lindzey, and T.P. Hemker. 1986. Predictive energetics model for cougars. Pp. 333-352 in *Cats of the World: Biology, Conservation and Management*. S.D. Miller and D.D. Everett, eds. Washington, D.C.: National Wildlife Federation.
- Anderson, A.E. 1983. *A Critical Review of Literature on Puma (Felis concolor)*. Special Report no. 54. Denver: Colorado Division of Wildlife.
- Ashman, D.L., G.C. Christensen, M.L. Hess, G.K. Tsukamoto, and M.S. Wickersham. 1983. *The Mountain Lion in Nevada*. Carson City: Nevada Department of Wildlife.
- Beier, P. 1991. Cougar attacks on humans in the United States and Canada. *Wildlife Society Bulletin* 19, 403-412.
- . 1992. Cougar attacks on humans: an update and some further reflections. In *Proceedings of the 15th Vertebrate Pest Conference*. J.E. Borrecco and R.E. Marsh, eds. Davis: University of California-Davis.
- . 1995. Dispersal of juvenile cougars in fragmented habitat. *Journal of Wildlife Management* 59:2, 228-237.
- Beier, P., D. Choate, and R.H. Barrett. 1995. Movement patterns of mountain lions during different behaviors. *Journal of Mammalogy* 76:4, 1056-1070.
- California Department of Fish and Game. N.d. *Outdoor California: Special Mountain Lion Issue* 57(3).
- Cunningham, S.C., L.A. Haynes, C. Gustavson, and D.D. Haywood. 1995. *Evaluation of the Interaction between Mountain Lions and Cattle in the Aravaipa-Klondyke area of Southeast Arizona*. Technical Report no. 17, Phoenix: Arizona Game and Fish Department.
- Fitzhugh, E.L. 1988. Managing with potential for lion attacks against humans. Pp. 74-76 in *Proceedings of the Third Mountain Lion Workshop, Prescott, AZ, Dec. 5-8, 1988*. R.H. Smith, ed. Phoenix: Arizona Chapter, The Wildlife Society, and Arizona Game and Fish Department.
- Hansen, K. 1994. *Cougar—the American Lion*. Flagstaff, Ariz.: Northland Publishing.
- . 1995. Return of the cougar. *American Forests* (January/February).
- Hofstra, T. 1995a. Draft mountain lion management guidelines. Unpublished manuscript. Orick, Calif.: Redwood National and State Parks.
- . 1995b. Track of the cat. *Ranger: Journal of the Association of National Park Rangers* (Summer), 10-11.
- Hopkins, R.A., M.J. Kutilek, and G.L. Shreve. 1986. The density and home range characteristics of mountain lions in the Diablo Range of California. Pp. 223-235

- in *Cats of the World: Biology, Conservation and Management*. S.D. Miller and D.D. Everett, eds. Washington, D.C.: National Wildlife Federation.
- Laycock, G. 1988. Cougars in conflict. *Audubon* (March).
- Leyhausen, P. 1979. *Cat Behavior: The Predatory and Social Behavior of Domestic and Wild Cats*. B.A. Tonkin, trans. New York: Garland STPM Press.
- Lindzey, F.G., W.D. Van Sickle, B.B. Ackerman, D. Barnhurst, T.P. Hemker, and S.P. Laing. 1994. Cougar population dynamics in southern Utah. *Journal of Wildlife Management* 58:4, 619-624.
- Lindzey, F.G., W.D. Van Sickle, S.P. Laing, and C.S. Mecham. 1992. Cougar population response to manipulation in southern Utah. *Wildlife Society Bulletin* 20, 224-227.
- Logan, K.A., L.L. Sweanor, J.F. Smith, B.R. Spreadbury, and M.G. Hornocker. 1990. *Ecology of an Unexploited Mountain Lion Population in a Desert Environment*. New Mexico Department of Game and Fish Annual Report. Santa Fe: New Mexico Department of Game and Fish.
- Mangus, G. 1988. Legal aspects of encounters on federal lands and in state programs. Pp. 43-44 in *Proceedings of the Third Mountain Lion Workshop, Prescott, AZ, Dec. 5-8, 1988*. R.H. Smith, ed. Phoenix: Arizona Chapter, The Wildlife Society, and Arizona Game and Fish Department.
- Mansfield, T.M. 1986. Mountain lion management in California. *Transactions of the North American Wildlife and Natural Resource Conference* 51, 178-182.
- Moorhead, B., and T. Hofstra. 1995. Western park personnel meet on mountain lion-human encounters. *Park Science* 14:4, 20-21.
- Murphy, K. 1994. The Yellowstone lion. *Yellowstone Science* (Spring).
- Redwood National and State Parks. 1995. Standard operating procedures (SOP): reporting and responding to mountain lion observations in Redwood National and State Parks. Unpublished manuscript. Orick, Calif.: Redwood National and State Parks.
- Ross, I.P., and M.G. Jalkotzy. 1992. Characteristics of a hunted population of cougars in southwestern Alberta. *Journal of Wildlife Management* 56:3, 417-426.
- Smallwood, K.S., and E.L. Fitzhugh. 1991. The use of track counts for mountain lion population census. In *Proceedings from Mountain Lion-Human Interaction Symposium*. C.E. Braun, ed. Denver: Colorado Division of Wildlife.
- . 1993. A rigorous technique for identifying individual mountain lions (*Felis concolor*) by their tracks. *Biological Conservation* 65, 51-59.
- Young, S.P. 1946. *The Puma: Mysterious American Cat*. Washington, D.C.: The American Wildlife Institute.